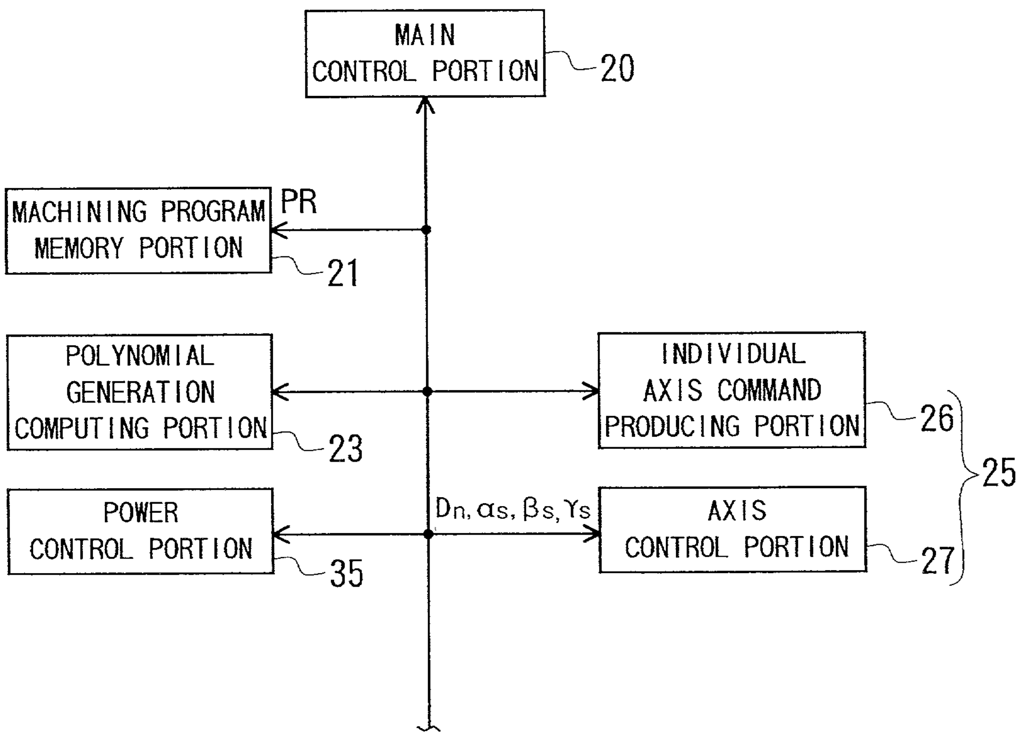
Fig.1



MAIN CONTROL PORTION
20
MACHINING PROGRAM MEMORY PORTION
PR
21
POLYNOMIAL GENERATION COMPUTING PORTION
23
INDIVIDUAL AXIS COMMAND PRODUCING PORTION
26
25
POWER CONTROL PORTION
35
Dn, αs, βs, γs
AXIS CONTROL PORTION
27

Fig.2

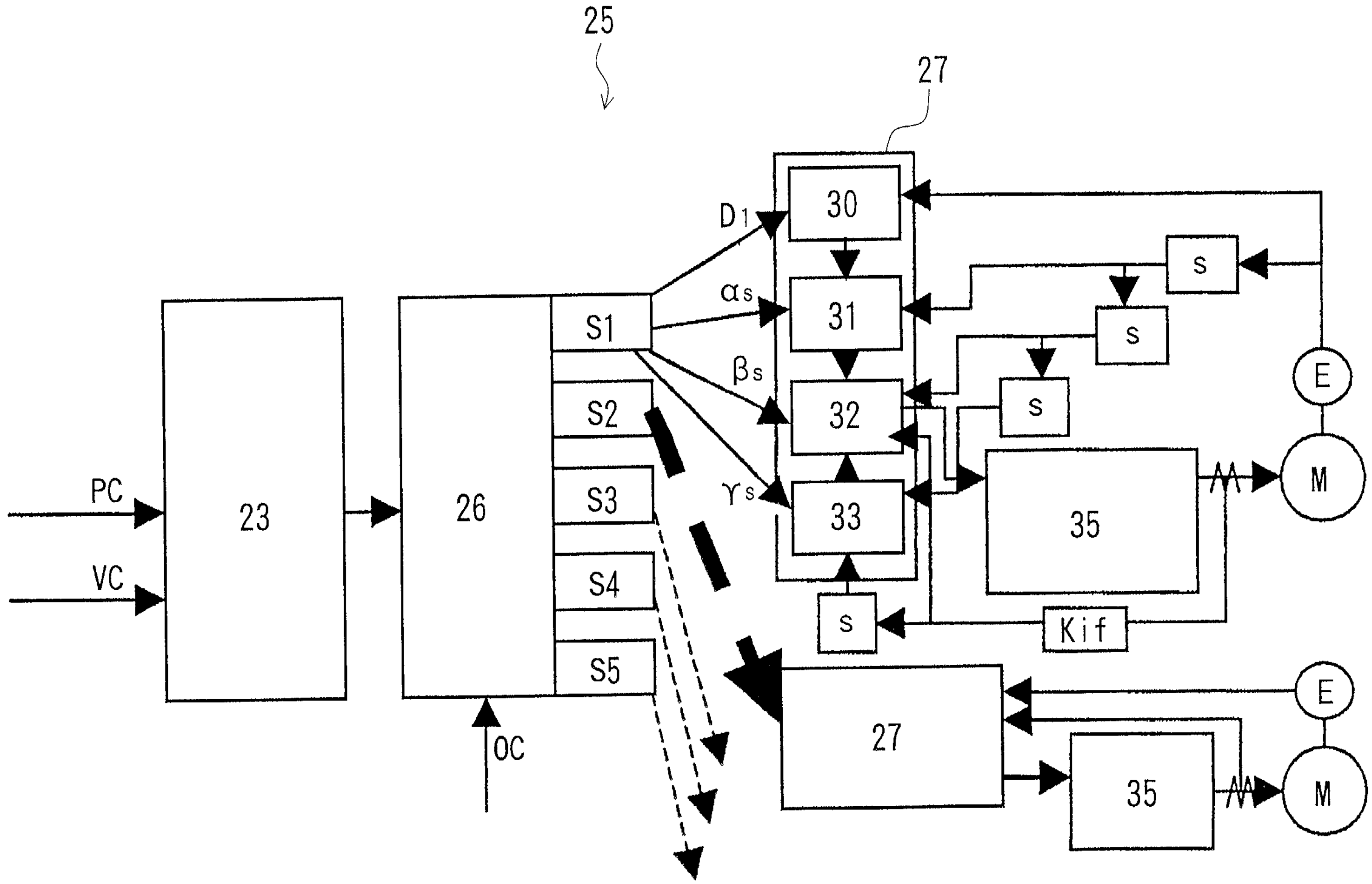

25
27
D1
αs
βs
γs
30
31
32
33
s
s
s
s
E
M
35
Kif
PC
VC
23
26
S1
S2
S3
S4
S5
OC
27
E
35
M

Fig.3

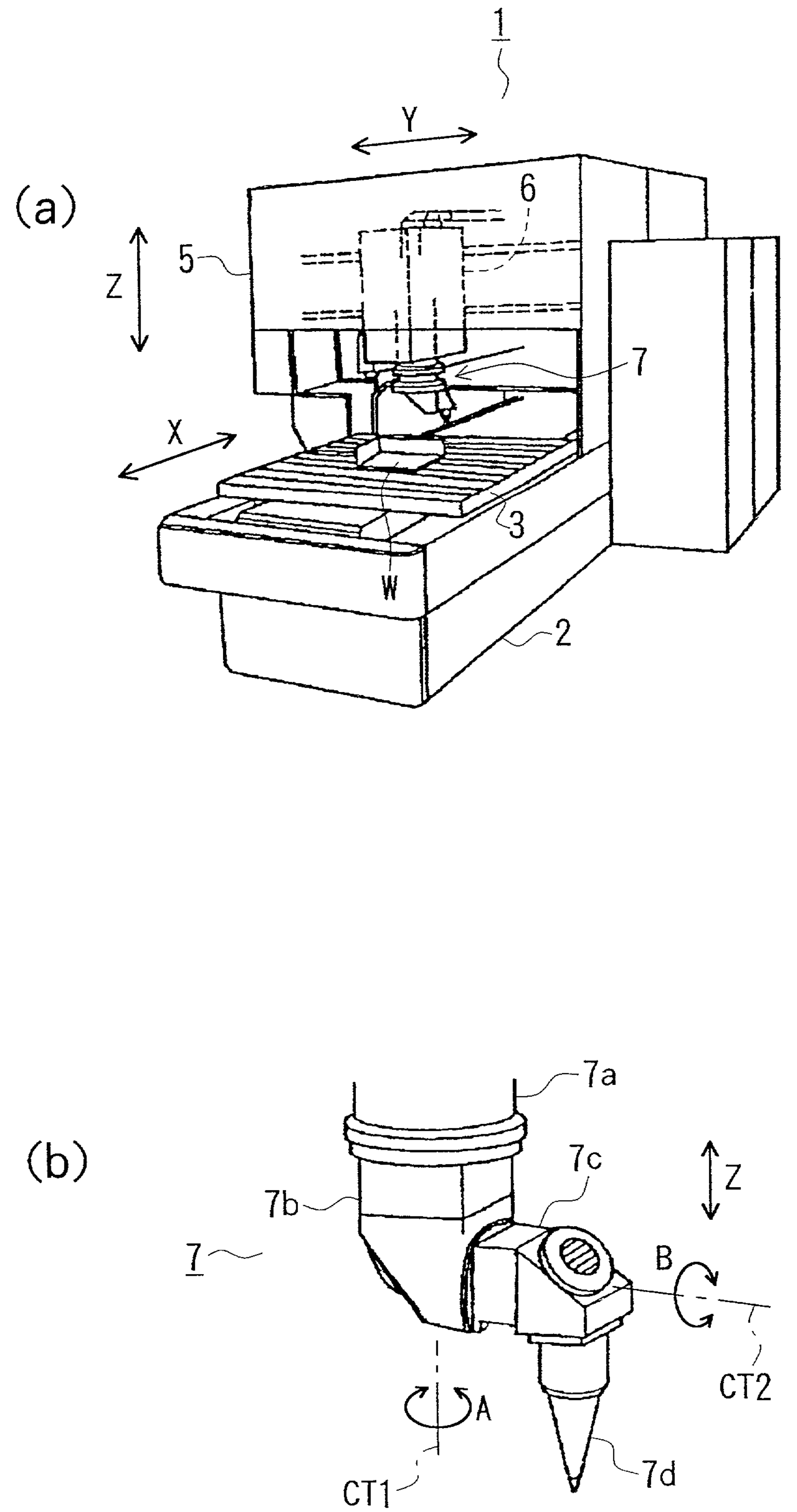


Fig.4

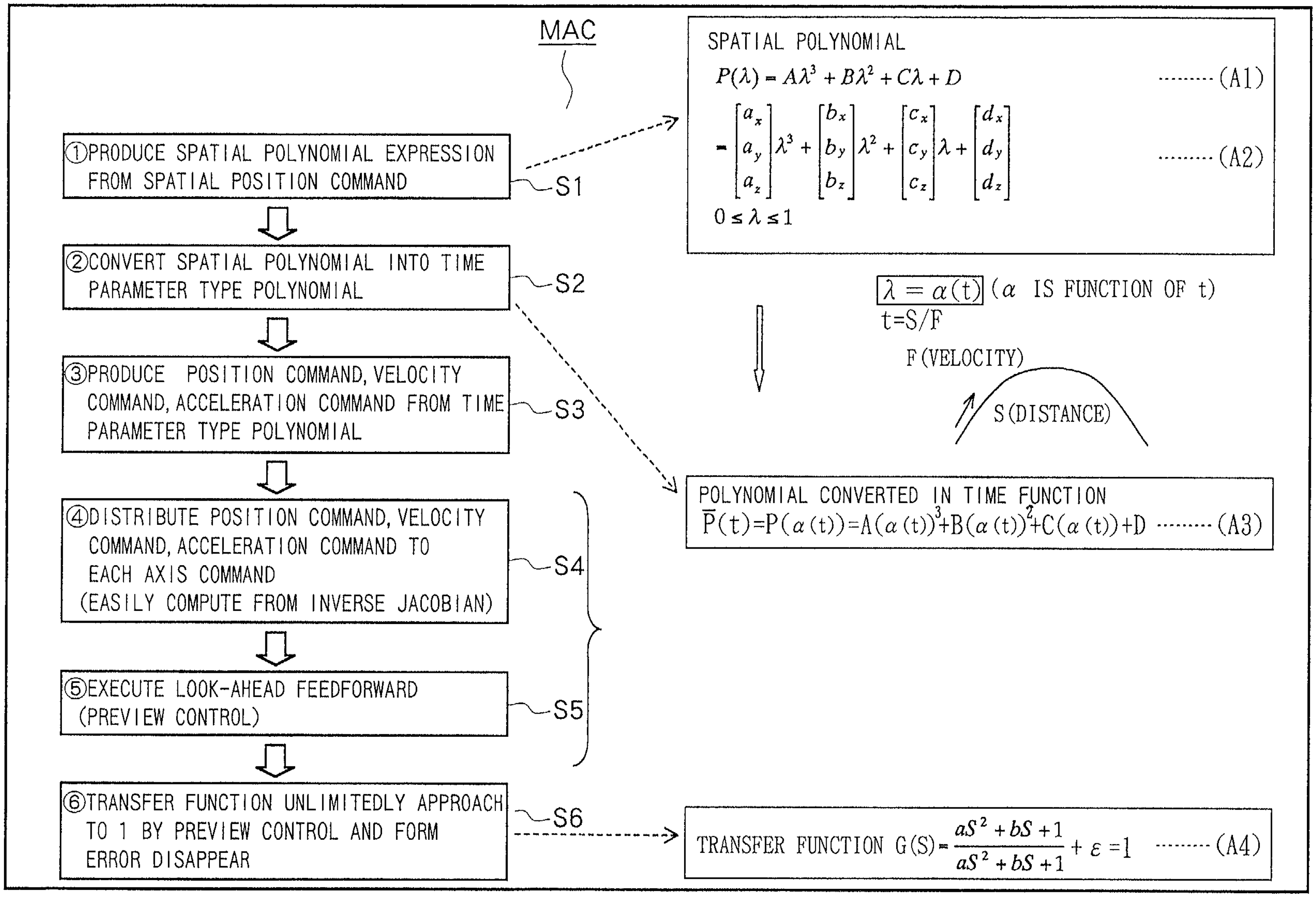
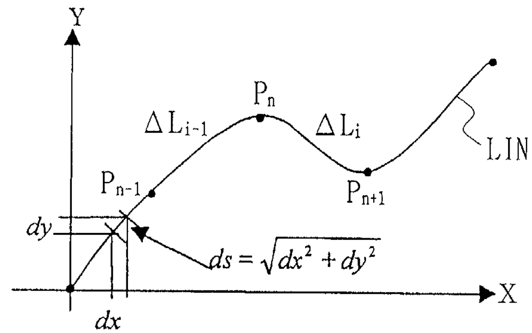

MAC
①PRODUCE SPATIAL POLYNOMIAL EXPRESSION FROM SPATIAL POSITION COMMAND
S1
②CONVERT SPATIAL POLYNOMIAL INTO TIME PARAMETER TYPE POLYNOMIAL
S2
③PRODUCE POSITION COMMAND, VELOCITY COMMAND, ACCELERATION COMMAND FROM TIME PARAMETER TYPE POLYNOMIAL
S3
④DISTRIBUTE POSITION COMMAND, VELOCITY COMMAND, ACCELERATION COMMAND TO EACH AXIS COMMAND (EASILY COMPUTE FROM INVERSE JACOBIAN)
S4
⑤EXECUTE LOOK-AHEAD FEEDFORWARD (PREVIEW CONTROL)
S5
⑥TRANSFER FUNCTION UNLIMITEDLY APPROACH TO 1 BY PREVIEW CONTROL AND FORM ERROR DISAPPEAR
S6
SPATIAL POLYNOMIAL
$P(\lambda) = A\lambda^3 + B\lambda^2 + C\lambda + D$ .... (A1)
$= \begin{bmatrix} a_x \\ a_y \\ a_z \end{bmatrix}\lambda^3 + \begin{bmatrix} b_x \\ b_y \\ b_z \end{bmatrix}\lambda^2 + \begin{bmatrix} c_x \\ c_y \\ c_z \end{bmatrix}\lambda + \begin{bmatrix} d_x \\ d_y \\ d_z \end{bmatrix}$ .... (A2)
$0 \le \lambda \le 1$
$\boxed{\lambda = \alpha(t)}$ (α IS FUNCTION OF t)
t=S/F
F (VELOCITY)
S (DISTANCE)
POLYNOMIAL CONVERTED IN TIME FUNCTION
$\overline{P}(t)=P(\alpha(t))=A(\alpha(t))^3+B(\alpha(t))^2+C(\alpha(t))+D$ .... (A3)
TRANSFER FUNCTION $G(S)=\dfrac{aS^2+bS+1}{aS^2+bS+1}+\varepsilon=1$ .... (A4)

Fig.5



IF LEFT DRAWING IS CURVED LINE DEFINED BY FOLLOWING POLYNOMIAL,

$$y = f(\lambda) = A\lambda^3 + B\lambda^2 + C\lambda + D \quad \cdots\cdots\cdots (B1)$$

$$x = g(\lambda)$$

$$\text{IF } 0 \leqq \lambda \leqq 1 \quad \cdots\cdots\cdots (B2)$$

IF WHOLE LENGTH OF CURVED LINE DEFINED IS L, FOLLOWING EXPRESSION CAN BE COMPUTED

$$L = \int_0^L ds = \int_0^L \sqrt{dx^2 + dy^2} = \int_0^1 \sqrt{\left(\frac{dx}{d\lambda}\right)^2 + \left(\frac{dy}{d\lambda}\right)^2} \cdot d\lambda \quad \cdots\cdots\cdots (B3)$$

FURTHERMORE, FOLLOWING LINE ELEMENT IS DEFINED BY CUTTING PARAMETER λ WITH SEQUENCE $0 = \lambda_0 < \lambda_1, \lambda_2, \cdots, \lambda_i, \cdots < \lambda_n = 1$

$$\Delta L_i = \int_0^{\lambda_i} \sqrt{\left(\frac{dx}{d\lambda}\right)^2 + \left(\frac{dy}{d\lambda}\right)^2} \cdot d\lambda \quad \cdots\cdots\cdots (B4)$$

GIVE VELOCITY PROFILE OF VELOCITY FUNCTION F(t) HAVING TIME PARAMETER t ON THIS CORVED LINE AND OBTAIN FOLLOWING EXPRESSION

$$\Delta L_i = \int_0^{t_i} F(t) \cdot dt \quad \cdots\cdots\cdots (B5)$$

λ AND t CAN BE RELATED WITH EACH OTHER BY MAKING LENGTH OF THIS LINE SEGMENT EQUAL TO LENGTH OF LINE SEGMENT(1)

$$\Delta L_i = \int_0^{\lambda_i} \sqrt{\left(\frac{dx}{d\lambda}\right)^2 + \left(\frac{dy}{d\lambda}\right)^2} \cdot d\lambda = \int_0^{t_i} F(t) \cdot dt$$

BY SOLVING THIS, FOLLOWING IS COMPUTED

$$\lambda = \alpha(t) \quad \cdots\cdots\cdots (B6)$$

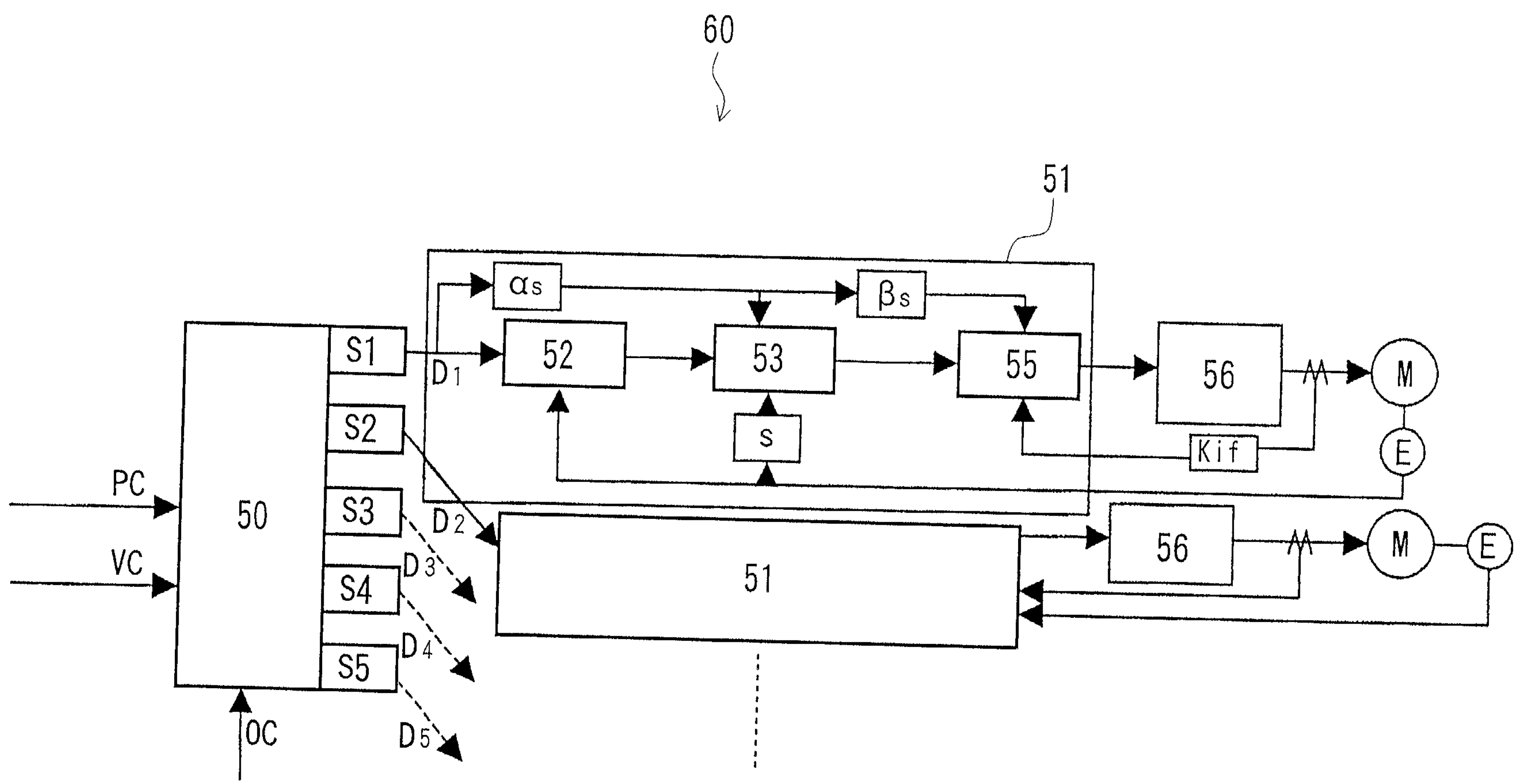
Fig.6

WORKING SPATIAL POSITION OF EACH AXIS CAN BE OBTAINED AS TIME FUNCTION BY $y=f(\alpha(t)), x=g(\alpha(t))$ FROM EXPESSION (3)

THEN, CONVERSION FROM WORKING SPACE OF EACH AXIS INTO JOINT SPACE CAN BE OBTAINED BY FOLLOWING RELATION

WORKING SPACE		CONVERSION		JOINT SPACE
$[x=g(\alpha(t)),\ y=f(\alpha(t))]$	$\Rightarrow$	INVERSE KINEMATICS	$\Rightarrow$	$[X, Y, A, B]$
$\downarrow$				
$[\dot{x}, \dot{y}]$	$\Rightarrow$	INVERSE JACOBIAN	$\Rightarrow$	$[\dot{X}, \dot{Y}, \dot{A}, \dot{B}]$
$\downarrow$				
$[\ddot{x}, \ddot{y}]$	$\Rightarrow$	INVERSE JACOBIAN	$\Rightarrow$	$[\ddot{X}, \ddot{Y}, \ddot{A}, \ddot{B}]$

Fig.7


60
51
αs
βs
52
53
55
56
s
Kif
M
E
S1
S2
S3
S4
S5
D1
D2
D3
D4
D5
50
PC
VC
OC
51
56
M
E